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Audiological and Vestibular Care of Patients with Parkinson's Disease (PD)

Melissa Newell, AuD

Clinical Assistant Professor

Purdue University, Department of Speech, Language, and
Hearing Sciences



Melissa Newell, AuD

Melissa D. Newell, AuD, Clinical Assistant Professor, has been a clinical instructor and clinical faculty member in the Speech, Language, and Hearing Sciences department since August 2015. She is the course instructor for “Vestibular Assessment and Rehabilitation”. Dr. Newell’s experience includes advanced vestibular assessment and collaboration with rehabilitation providers. She currently supervises and teaches first and second-year Au.D. students in the Purdue Audiology Clinic.



Disclosures

- **Presenter Disclosure:** Financial: Melissa Newell is employed by Purdue University. She received an honorarium for presenting this course. Non-financial: Melissa Newell has no relevant non-financial relationships to disclose.
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- Providers should always evaluate the limitations of diagnostic and screening tools, considering their potential for false results as well as any ethical implications.
- It is the responsibility of course participants to critically evaluate the evidence from multiple sources to guide professional practice.



Learning Outcomes



After this course, participants will be able to describe the common vestibular and auditory symptoms associated with Parkinson's disease and explain how PD's pathology can impact balance and hearing.



After this course, participants will be able to explain how to interpret comprehensive diagnostic test results for a patient with PD, distinguishing peripheral vestibular findings from PD-related central signs.



After this course, participants will be able to discuss how to assess the functional impact of dizziness and hearing loss in PD patients using standardized questionnaires.

Agenda

0-5 Minutes	Introduction
5-15 Minutes	Background on PD
15-20 Minutes	Symptoms
20-35 Minutes	Diagnostic Findings
35-40 Minutes	Questionnaires/Functional Impact
40-50 Minutes	Prognosis and Planning
50-55 Minutes	Treatment and Management Strategies
55-60 Minutes	Summary & Q/A



Background: Parkinson's Disease and Sensory Impairments



TARP:

T-Tremors

R-Rigidity

A-Akinesia (slowness of movement)

P-Postural Instability

- Parkinson's disease (PD) is a progressive neurodegenerative disorder classically characterized by **motor symptoms (MS)**.
 - Resting tremor
 - Rigidity
 - Bradykinesia
 - Postural instability/chronic unsteadiness
- In addition to motor deficits, PD patients frequently experience **non-motor symptoms (NMS)**, including sensory impairments.

- **Dizziness and imbalance** are twice as prevalent in PD patients compared to age-matched elders without PD.
- Balance disorders (postural instability, unsteadiness) are common and significantly reduce quality of life in PD.
- These symptoms have often been overlooked, but evidence indicates that vestibular system dysfunction is **prevalent** in PD and contributes to **fall risk**.



- Pathological studies have even identified Parkinsons-related changes (Lewy bodies) in central vestibular structures (e.g., vestibular nuclei), suggesting a direct neurological link between PD and *vestibular dysfunction*.
- PD-related vestibular deficits may manifest as impaired vestibulo-spinal reflexes and abnormal balance integration, even if overt vertigo is not reported.



Statistics

15% of PD patients have a family history of the disease

Most PD causing mutations are related to early onset (at least 12 mutations)

Several mutations cause PD after 50 years of age (more common)

GBA and LRRK2 are the two most common genetic causes of PD

Typically occurs around 60 or older

Life expectancy is reduced if diagnosed before the age of 70

Twice as common in men

Women tend to have faster disease progression

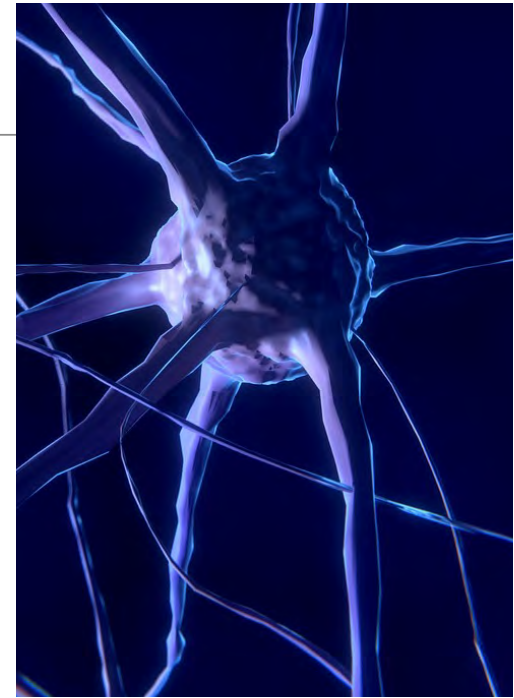
Most of the time, there is no clear cause

2nd most common neurodegenerative disorder in US (following Alzheimer's disease)



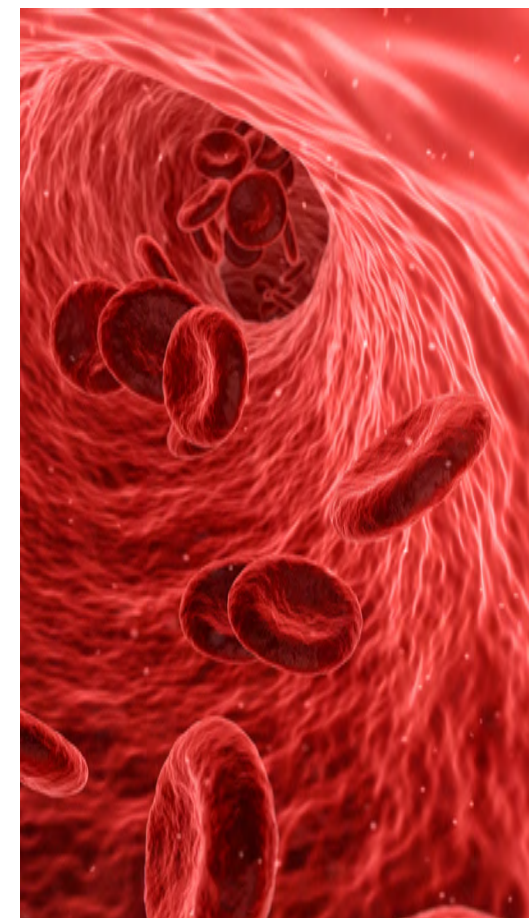
Motor Symptoms

- Four Main Symptoms:
 - **T: Tremor**
 - Pill rolling
 - Resting tremor
 - **R: Rigidity**
 - Cogwheel (muscles jump—often in upper body)
 - lead pipe (muscles won't move—often in lower body)
 - **A: Akinesia** (no movement) or bradykinesia (little movement)
 - Often have a “mask face”
 - **P: Postural instability**: often hunched over



Non-Motor Symptoms (NMS)

- Loss of norepinephrine (which is made from dopamine): Main chemical messenger of the sympathetic nervous system
- Results in non-motor symptoms (NMS) in persons with PD.
 - Fatigue
 - Irregular blood pressure
 - Poorer movement of food through digestive tract
 - Sudden drop in BP when standing
 - Cognitive problems
 - Mental health concerns
 - Emotional changes



Ten Early Signs of PD

Tremor

Smaller handwriting (micrographia)

Loss of smell

Trouble sleeping

Trouble moving or walking (feel stuck to floor)

Constipation

Soft or low voice

Masked face

Dizziness or fainting

Stooping or hunching over





Etiology

Dopaminergic neurons (neurons that produce dopamine) are not functioning or dying.

Found in the basal ganglia (in substantia nigra)

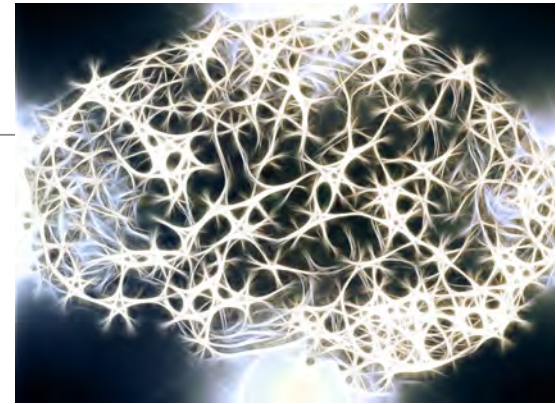
- Basal ganglia: controls movement

Dopamine causes either inhibition or excitation to occur in nerve cells along motor pathways for motor movement.

When dopamine production is affected, other neurotransmitters (GABA/Glutamate) are not transmitted properly.

Inhibition and excitation of motor cells do not occur properly, resulting in no or altered movement.





Lewy Bodies

- Formation of protein clumps in brain cells
- Present in other neurologic disorders
- Toxic to nerve cells
- Spread through the brain in a “prion-like” manner.
 - Protein clumps in one part of the brain can trigger more clumps to form nearby
- Main component: alpha-synuclein (experimental therapies targeting this protein in clinical development)
- Found in patients with Lewy body dementia (LBD)—results in cognitive problems.

Treatment

- L-Dopa
 - Can cross blood-brain barrier
 - Improves motor function
 - Does not help with cholinergic neuron loss in the PPN; which explains why typical L-Dopa does not always improve postural instability, freezing of gait and abnormal ocular eye movements.
 - **Anticholinergics** can be used, but can cause increased confusion in elderly patients
- Medications for NMS:
 - SSRIs for anxiety and depression
 - Antipsychotic medications as needed
- Amantadine: for managing dyskinesia (involuntary movements)



Hereditary vs. Environmental Causes

- Possible combination of genetics and how environmental exposures can increase risk for PD
- Environmental Risk Factors:
 - Head Trauma
 - Geographic location
 - Occupation
 - Metal Exposure
 - Solvents and Polychlorinated Biphenyls (PCBs)
 - Solvent—Trichloroethylene (TCE)
 - Most common organic contaminant in groundwater
 - PD risk increases with a history of exposure to **pesticides and herbicides**
 - Paraquat: used in the US; banned in 32 countries



Causes of Dizziness and Imbalance

Orthostatic Hypotension

- Weakness
- Difficulty thinking—foggy/memory problems
- Headache
- Blurred or dimmed vision

Medication-Induced Symptoms

- Anticonvulsants, antihypertensives, antibiotics, antidepressants, antipsychotics, pain and anti-inflammatory medications



Causes of Dizziness and Imbalance

Deep Brain Simulation (DBS)

- Usually occurs just after surgery and resolves

BPPV

- May be an increased risk for patients with PD

TIA or Stroke

Anxiety

Dehydration, heart conditions, migraine and others



VOR and VSR

- Vestibulo-ocular reflex (VOR): Reflex between ocular muscles and semicircular canals. Maintains vision with head movements.
- Vestibulospinal reflex (VSR): Reflex between the utricle/sacculle and muscles to make automatic body posture and muscle tone changes to maintain balance and upright posture.



Vestibular Causes of Dizziness and Balance Disorders



Central, peripheral, or both? **Yes**



Dizziness and postural instability are twice as prevalent in patients with PD (compared to older counterparts)



Dizziness is the most common symptom that PD patients describe (48-68%).

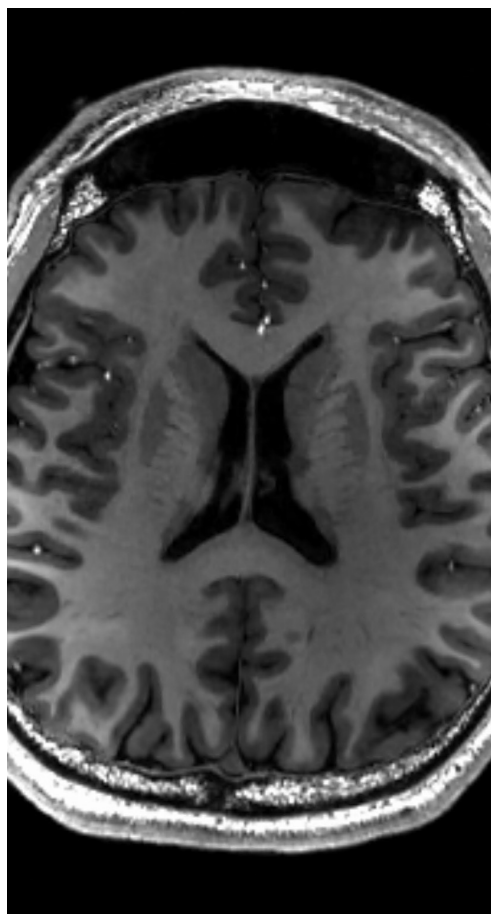
Orthostatic hypotension is a common cause, but can be multi-factorial



Prior to PD diagnosis, patients may report dizziness for years (possible prodromal symptom)



Peripheral Vestibular Structures



- Limited studies looking at anatomical peripheral structures
 - However, alpha-synuclein pathology is widespread and known to affect other peripheral nervous systems.
 - Possible nerve fiber changes in peripheral vestibular system, but not visible on imaging
- PD patients often have peripheral abnormalities on comprehensive vestibular assessments
 - Higher prevalence of hypofunction
 - Hypofunction will increase postural instability

Central Vestibular Structures

Postural Instability (PI): A major contributor to falls. Increases with disease progression.

PD patients have an impaired ability to interpret peripheral vestibular information along with vision and proprioception

Pisa Syndrome (PS): Lateral trunk flexion of 10 degrees or more. When present, cVEMPs are often absent bilaterally.

Freezing of Gait (FoG): episodes of “freezing” or inability to move slightly. Typically occurs during gait initiation or turning. Possibly due to poorer postural sensory processing and difficulty integrating vestibular input.

Abnormal eye movements: Impaired saccades (vestibular nucleus, oculomotor nucleus and basal ganglia are all affected)

Pedunculopontine Nucleus (PPN) is involved in vestibular processing and sensory integration. Dysfunction is common, resulting in increased gait and posture issues. Less is known about the degeneration of cholinergic neurons.

- **Cholinergic** neurons (neurotransmitter) degenerate, particularly in the PPN.



Vestibular Tests

- Assessments of the VOR: research is controversial
- Reduced/absent caloric responses are associated with increased postural instability
- Unilateral hypofunction is more common in patients exhibiting lateral trunk flexion
- Some research indicates that gain is abnormally high
- Suppression Head Impulse Test Paradigm (SHIMP): gain unaffected in PD patients, but longer saccade latency and reduced saccade velocity
- Hypometric saccades
- Abnormal smooth pursuit



Vestibular Tests

- VEMPs: ocular and cervical
 - Often absent, delayed, or reduced in amplitude
 - Correlate with disease progression and symptom severity
 - Degree of VEMP abnormality is linked to REM Sleep Behavior Disorder and postural instability
- Subjective Visual Vertical (SVV): inconsistent results. Needs further research as patients with PD often have difficulty knowing their orientation and position in space.



Questionnaires

- Can use questionnaires to determine care needs:
 - Dizziness Handicap Inventory
 - Berg Balance Scale
 - Dizziness Symptom Profile
 - Hospital Anxiety and Depression Scale (HADS)
 - Parkinson's Disease Quality of Life Questionnaire (PDQ-39)
 - STEADI program



Sleep Disorders in PD

Insomnia

REM Sleep Behavior Disorder (RBD): physically acting out dreams

Excessive Daytime Sleepiness (EDS)

Restless Leg Syndrome

Sleep Apnea

Circadian Rhythm Sleep Disorders

Vivid Dreams/Nightmares





Mental Health Concerns

- Anxiety and depression—due to lifestyle, health, and brain chemistry changes
 - 40% of people with PD: may be the first symptom noticed
 - 50% of people with PD
- Dopamine, GABA, and serotonin production are all affected by PD
- “Off” Periods—medication tends to wear off in between doses. Symptoms may worsen
- Isolation can increase symptoms-support groups can help
- Life stressors can increase symptoms
- At risk for anxiety induced dizziness



Cognitive/Mental Symptoms

- Common concerns:
 - Anxiety
 - Hallucinations
 - Memory Problems
 - Depression
 - Apathy
 - Impulse control disorders
 - Dementia
- Nearly $\frac{1}{2}$ of all patients with PD have anxiety and depression



Hearing Loss and PD

Increased incidence of hearing loss compared to age matched controls

Speech in noise difficulties may be an early indicator, sometimes occurring up to five years before PD diagnosis.

For every 10 dB increase in hearing impairment, there is a higher risk of PD

Auditory pathways: possible neurodegenerative effects

Auditory Processing Disorder (APD): neurological processing issues in PD

Medication effects: ototoxic medications for PD

Cognition: Worsening cognition makes it more difficult to assess hearing and to determine if hearing aids are beneficial



Hearing Aids and PD

Improved Communication: may reduce feelings of isolation and frustration

Addressing auditory processing issues: HAs may not be enough

Possible reduction in risk of developing PD: large scale study of veterans wearing HAs for 2 years

Use of assistive listening devices

Use of assistive listening devices

Counseling of patient and family members

Aid in referring patients for vestibular testing, mental healthcare, OT, PT, ST

We see our HA patients over a long period of time: Can monitor progression and improve quality of life for patients

Improved social interaction and cognitive function





Caloric Vestibular Stimulation (CVS)

- Device that applies controlled temperature changes to the ear canal (cool and warm air)
- Stimulation of the vestibular system helps to modulate brain function and blood flow
- Aims to improve neural connectivity, which should improve symptoms
- Research has shown that there are improvements in motor symptoms and non-motor symptoms, with improved quality of life and daily living scores.
- Participants reported that it was tolerable and manageable to use
- Possible long-term effects after therapy



Deep Brain Stimulation (DBS)

- Electrodes implanted into specific areas of the brain
- Reduces severe tremors and dyskinesia
 - Works best on people who respond well to levodopa therapy
 - Can offer long-term symptom improvement
 - Does not halt or slow the progression of the disorder



Vestibular Rehabilitation Therapy (VRT)

Highly recommended and effective treatment

- Improves balance impairments
- Reduces fall risks
- Improves neuroplasticity—effects can be seen over time
- Reduces symptoms
- Repairs function
- Promotes adaptation

Patients with PD should have comprehensive audiometric and vestibular assessments.



PT and OT: assistive devices and lifestyle modifications

Mobility aids: walkers, crutches,

- U-step walker: specifically for PD patients when freezing

Adaptive equipment: grab bars, raised toilet seats, shower chairs

Goal is to help maintain independence

Address fear of falling

Learning to adapt to changing needs



Reducing the risk of PD



Anti-inflammatory drugs (ex., ibuprofen)



Smoking: Nicotine may protect against PD



Vitamin D: needs more research



Exercise: Very important and exercising earlier in life may help



Caffeine: may reduce risks



Uric acid or urate: may help men, but unclear in women



Diet and Nutrition



- Diet is extremely important for this patient population.
- Whole-food, plant-based diet is best
- Water and fiber rich foods to help with digestive issues
- Water helps break down medications
- Sugar, caffeine and alcohol may disrupt sleep, which is vital for PD patient

Diet and Nutrition

- Discuss Vitamin D needs with physician to maintain bone health
- Brain health: May be improved by eating small amounts of walnuts, cashews, and other nuts.
- Anti-inflammatory foods: salmon, tuna, and dark, leafy green vegetables
- PD meds work best on an empty stomach, but some patients experience nausea. Working with physicians and a dietitian can help.



Interprofessional Care for Nutrition

Dietitians specializing in PD can help develop meal plans

Occupational therapists can assess and provide devices if eating and drinking are difficult

Mental Healthcare: Depression and anxiety are common and may affect appetite.

Speech pathology: Can provide a swallow evaluation and treatment if swallowing is a problem.

Dentistry: High risk for dental and gum problems

Goal is to ease symptoms



Gaps in evidence and further needs.....

Limited studies on peripheral vestibular function

- Complicated by medications. When do you test? Do results change based on medication levels or other health issues? Is the patient in an “off” time?

Most studies are completed on animals

VRT protocols need optimizing

Earlier identification and treatment. Can vestibular assessments be part of earlier ID?

Collaboration between fields

Optimizing treatment options





Take away

- Audiology has an important role in the care of patients with PD
- Comprehensive vestibular and audiological assessments, with monitoring, are indicated
 - Hearing aids and counseling are important!
- Fall risk should be addressed
- VRT is an important part of treatment for this population



Thank you!

Melissa Newell, AuD



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